Fire Test for Evaluation of Valve Stem Packing

API STANDARD 589
SECOND EDITION, JULY 1998

American Petroleum Institute

Helping You Get The Job Done Right.SM

Fire Test for Evaluation of Valve Stem Packing

Manufacturing, Distribution and Marketing Department

API STANDARD 589
SECOND EDITION, JULY 1998

American Petroleum Institute

Helping You Get The Job Done Right.SM

SPECIAL NOTES

API publications necessarily address problems of a general nature. With respect to particular circumstances, local, state, and federal laws and regulations should be reviewed.

API is not undertaking to meet the duties of employers, manufacturers, or suppliers to warn and properly train and equip their employees, and others exposed, concerning health and safety risks and precautions, nor undertaking their obligations under local, state, or federal laws.

Information concerning safety and health risks and proper precautions with respect to particular materials and conditions should be obtained from the employer, the manufacturer or supplier of that material, or the material safety data sheet.

Nothing contained in any API publication is to be construed as granting any right, by implication or otherwise, for the manufacture, sale, or use of any method, apparatus, or product covered by letters patent. Neither should anything contained in the publication be construed as insuring anyone against liability for infringement of letters patent.

Generally, API standards are reviewed and revised, reaffirmed, or withdrawn at least every five years. Sometimes a one-time extension of up to two years will be added to this review cycle. This publication will no longer be in effect five years after its publication date as an operative API standard or, where an extension has been granted, upon republication. Status of the publication can be ascertained from the API Manufacturing, Distribution and Marketing Department [telephone (202) 682-8000]. A catalog of API publications and materials is published annually and updated quarterly by API, 1220 L Street, N.W., Washington, D.C. 20005.

This document was produced under API standardization procedures that ensure appropriate notification and participation in the developmental process and is designated as an API standard. Questions concerning the interpretation of the content of this standard or comments and questions concerning the procedures under which this standard was developed should be directed in writing to the director of the Manufacturing, Distribution and Marketing Department (shown on the title page of this document), American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005. Requests for permission to reproduce or translate all or any part of the material published herein should also be addressed to the director.

API standards are published to facilitate the broad availability of proven, sound engineering and operating practices. These standards are not intended to obviate the need for applying sound engineering judgment regarding when and where these standards should be utilized. The formulation and publication of API standards is not intended in any way to inhibit anyone from using any other practices.

Any manufacturer marking equipment or materials in conformance with the marking requirements of an API standard is solely responsible for complying with all the applicable requirements of that standard. API does not represent, warrant, or guarantee that such products do in fact conform to the applicable API standard.

FOREWORD

This standard covers the requirements for testing and evaluating the performance of valve stem packing when it is exposed to specifically defined fire conditions. The requirements described in this standard establish performance limits for evaluating valve stem packing acceptability. Purchasers may wish to establish more stringent requirements to meet their specific applications.

This standard does not address exposure to long-term high temperature conditions or aging characteristics of packing components.

Those testing packing in accordance with this standard are encouraged to submit the data gathered during testing to the director of the Manufacturing, Distribution and Marketing Department.

API publications may be used by anyone desiring to do so. Every effort has been made by the Institute to assure the accuracy and reliability of the data contained in them; however, the Institute makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use or for the violation of any federal, state, or municipal regulation with which this publication may conflict

Suggested revisions are invited and should be submitted to the director of the Manufacturing, Distribution and Marketing Department, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

CONTENTS

Fire Test for Evaluation of Valve Stem Packing

1 Scope

1.1 This standard covers the requirements for testing and evaluating the performance of valve stem packing when it is exposed to a fire as defined in this standard. Packing may be a combination or an arrangement of more than one material. The test procedure in this standard simulates circumstances that impose severe demands on valve stem packing.

1.2 The requirements described in this standard establish performance limits for evaluating valve stem packing acceptability.

Note: The maximum acceptable leakage rates given in this standard are for the test temperatures and pressures specified. Leakage rates of valves in service during and after an actual fire may be substantially different.

2 References

The most recent editions of the following standards are cited in this publication.

API

Std 600 *Steel Gate Valves—Flanged and Butt-Welding Ends*

ASME[1]

B46.1 *Surface Texture (Surface Roughness, Waviness, and Lay*)

3 Fixture for Fire Test

3.1 Packing shall be evaluated either in a carbon steel, Class 300, NPS 6,8,10, or 12 gate valve conforming to API Standard 600 or in a test fixture. If a test fixture is used, it shall include a vessel representative of a carbon steel, Class 300 gate valve body and bonnet and shall have integrally attached a matching simulated stuffing box and a stem. The simulated stuffing box and stem shall have dimensions as specified in API Standard 600. Gland, gland flange, and gland bolting shall also be representative of those in a carbon steel, Class 300 gate valve of the simulated NPS. The simulated stem shall be capable of traveling at least 150 mm (6 inches) through the simulated stuffing box. In either case, means shall be provided to prevent stem rotation. Any subsequent reference to test valve means valve or test fixture.

To assure that the test pressure reaches the packing area of the test valve and to assure uniformity, the following diametrical clearances in the packing area have been established:

1. Stem outside diameter to backseat bushing bore, 1.2 mm ± 0.25 mm (0.050 inch ±0.010 inch);
2. Stem outside diameter to gland bore, 1.2 mm ±0.20 mm (0.050 inch ±0.010 inch); and
3. Gland outside diameter to stuffing box bore, 1.2 mm ± 0.25 mm (0.050 inch ± 0.010 inch).

The test valve (or fixure) shall have the following surface finishes in the packing area: stem outside diameter, 0.8 micrometer (32 microinches) maximum roughness (in accordance with ASME B46.1); and the stuffing box bore 3.1 micrometers (125 microinches) maximum roughness. Dimensions and tolerances to be reconfirmed before use of the test valve (or fixture) for another test.

3.2 The test valve shall be filled with water and tested in the half-open position with the stem and bore horizontal. The downstream end of the test valve shall be blanked. The test valve shall be arranged or installed to provide a vapor trap that minimizes the cooling effect of the upstream liquid (see Figures 1 and 2).

3.3 Potential leakage from sources other than the stuffing box, such as from piping-to-valve end-connections or the bonnet joint, is not included in the allowable leakage rates specified in Section 7. To isolate stuffing box leakage, it may be necessary to modify the end-connections and/or the bonnet joint.

3.4 The minimum size of piping and shutoff valve (Items 7 and 9 in Figures 1 and 2) shall be NPS $1\text{-}^1/_2$.

4 Fire-Test Conditions

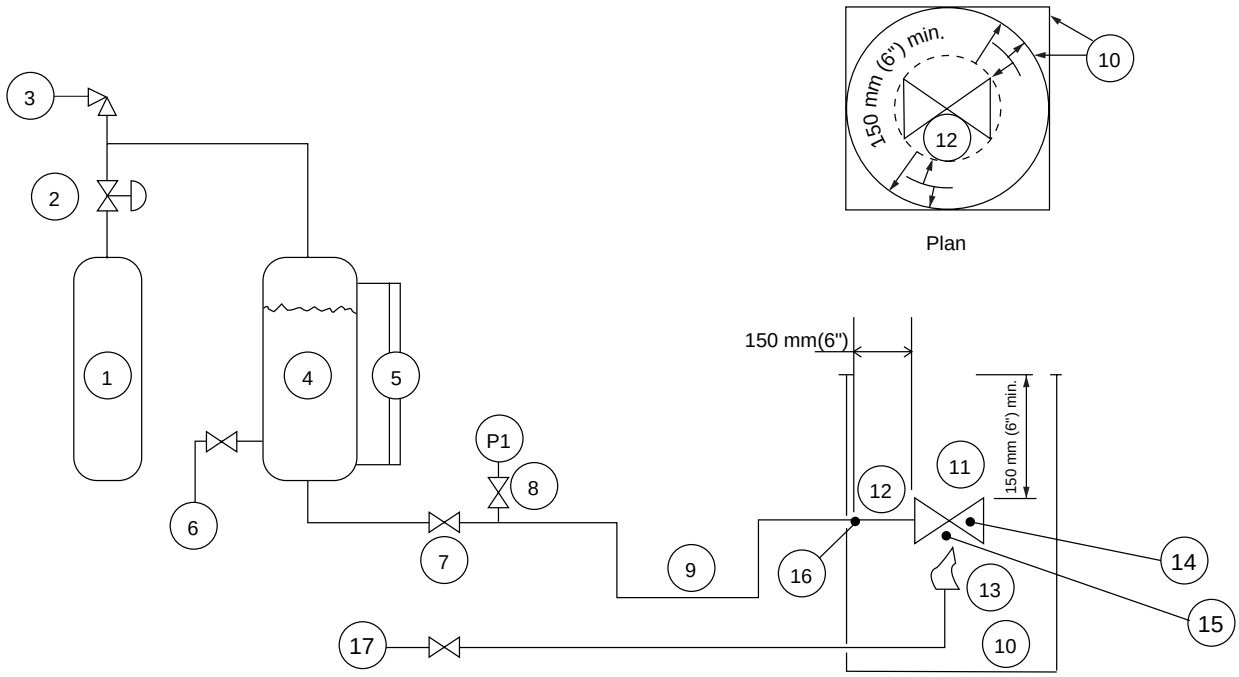
4.1 The test valve shall not be protected with insulating material in any way during the test.

4.2 The total test exposure time shall be 30 minutes. This includes a heat-up time of 15 minutes or less (see 4.5).

Note: The burn duration of 30 minutes was selected because it represents the maximum time required to extinguish most refinery fires. Fires of greater duration are considered major fires, with greater consequences than those anticipated by this test.

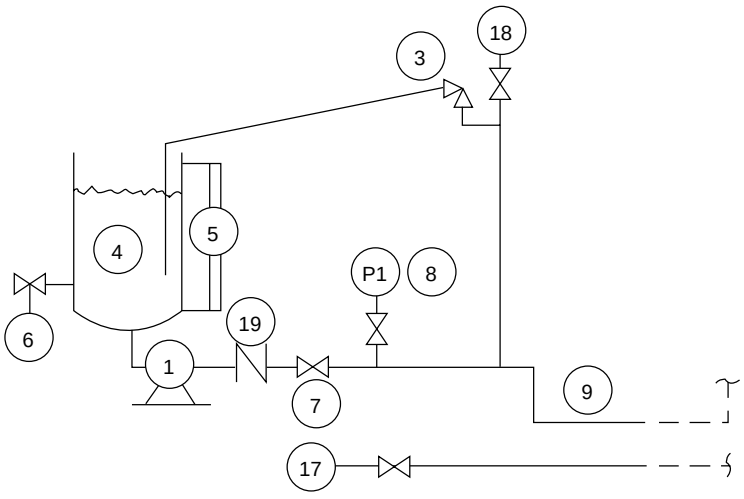
4.3 The test valve shall be enveloped in flame that has an initial average temperature of 760°C to 980°C (1400°F to 1800°F). The flame source shall be a minimum of 300 mm (12 inches) from the stuffing box. The flame temperature shall be the average of at least two thermocouple readings with no reading less than 705°C (1300°F). The thermocouples shall be located opposite one another at a radial distance of approximately 25 millimeters (1 inch) from the outside surface of the stuffing box, as shown in Figure 3. The thermocouples should not be placed close to lugs or gussets integral with the stuffing box.

[1]American Society of Mechanical Engineers, 345 East 47th Street, New York, New York 10017.



Legend:
1. Pressure source.
2. Pressure regulator.
3. Relief valve.
4. Vessel for water.
5. Calibrated sight gauge (or similar device).
6. Water supply.
7. Shutoff valve.
8. Pressure gauge.
9. Piping, arranged to provide vapor trap.
10. Enclosure for test. [The horizontal clearance between any part of the valve and the enclosure shall be a minimum of 150 millimeters (6 inches).]
11. Minimum height of the enclosure shall be 150 millimeters (6 inches) above the top of the valve.
12. Test valve and stem mounted horizontally.
13. Fuel gas burner.
14. Stuffing box wall thermocouples.
15. Flame temperature thermocouples.
16. Optional thermocouples on surface of upstream pipe.
17. Fuel gas inlet.

Figure 1—Typical Fire-Test System Using Compressed Gas as the Pressure Source



Legend:
1. Pressure source.
3. Relief valve.
4. Vessel for water.
5. Calibrated sight gauge (or similiar device).
6. Water supply.
7. Shutoff valve.
8. Pressure gauge.
9. Piping, arranged to provide vapor trap.
17. Fuel gas inlet.
18. Vent valve.
19. Check valve.

Note: A pump, with appropriate control devices, may be used as a pressure source provided that the system delivers a reasonably nonpulsating pressure.

Figure 2—Typical Fire-Test System Using a Pump as the Pressure Source

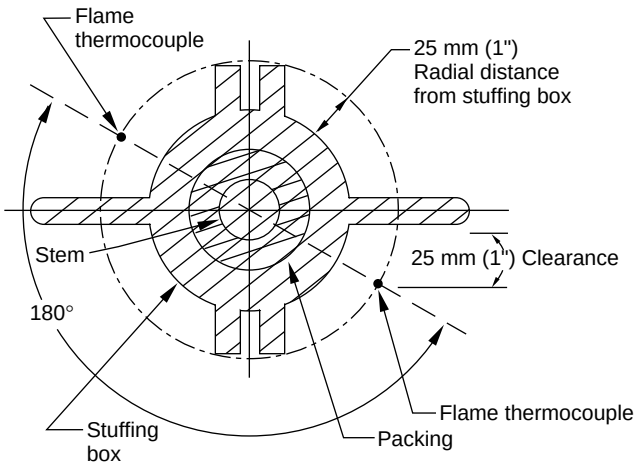


Figure 3—Location of Thermocouples for Flame Temperature Measurement

4.4 In addition to the two thermocouples for measuring flame temperature, the test apparatus shall include at least two thermocouples mounted in the stuffing box wall, as shown in Figure 4.

4.5 During the 30-minute test exposure period, the gas feed shall be adjusted so that the average temperature of the stuffing box thermocouples shall reach a minimum of 650°C (1200°F) in 15 minutes or less. During the remainder of the 30-minute test, the gas feed shall be regulated so that the stuffing box thermocouples shall maintain this minimum temperature. The flame temperature may be adjusted as required to maintain the stuffing box temperatures within the limits specified above.

4.6 The following CAUTION shall be observed:

CAUTION: For the safety of the personnel conducting the test and because of environmental considerations, the following is required:

a. All test equipment and the test valve shall be clean and in good operating condition.
b. Water shall be used as the test medium.
c. Personnel shields shall be provided.
d. Gaseous fuel shall be used.

4.7 The nominal test pressure shall be 3.72 MPa (540 pounds per square inch gauge) ±10 percent during the fire-test and cooling-down period.

5 Test Layout

Figures 1 and 2 show typical arrangements for fire-test equipment. Other means may be used to control system pressure provided that they satisfy all other requirements of this standard.

6 Test Procedure

6.1 PRETEST OPERATIONS

6.1.1 Packing shall be installed in the test valve or fixture no more than three days prior to conducting the fire test. Details of the procedure actually used shall be recorded in the test log and included in the Test Result Summary (Appendix A).

6.1.2 Initial packing compression shall conform to the packing manufacturer's specification. Torque on the gland nuts and packing compression displacement shall be measured and recorded at the beginning of the test.

6.1.3 The stem shall be moved the approximate equivalent of one hand-wheel turn back toward the closed position to ensure that the backseat is unseated.

6.1.4 A hydrostatic test pressure of 7.76 MPa (1125 psig) shall be applied to the test valve for a minimum of 120 seconds. Any leakage shall be recorded. If necessary to stop packing leakage, additional packing compression may be applied at this time. The final torque on the gland nuts and the final compression shall be recorded in Appendix A.

6.1.5 The gland adjustment length shall be checked for compliance with 6.4 of API Standard 600. If not in compliance, a new packing set with additional rings (or height) shall be installed and the hydrostatic test repeated.

6.2 STEPWISE PROCEDURE FOR FIRE TEST

To perform the fire test, follow the stepwise test procedure described in 6.2.1 through 6.2.8.

6.2.1 Open the valve or valves at the water source and open any necessary vent and drain valves to ensure that the body cavity is filled with water.

6.2.2 Operate the test valve or fixture to move the stem to the half-open position. Close all drain and vent valves and close the water supply valve. The test valve and the system upstream of the test valve shall be completely filled with water.

6.2.3 Pressurize the system to the test pressure specified in 4.7; then check the entire system carefully for leaks and eliminate them. Record any adjustments made to packing compression as required in 6.1.2. No adjustments to the packing gland shall be made for the remainder of the fire test.

6.2.4 Record the amount of water in the vessel (Item 4 of Figures 1 and 2).

6.2.5 Open the fuel supply valve and establish the fire. The burn period will be 30 minutes from ignition. Maintain the test conditions as stipulated in 4.3 through 4.7. Momentary pressure losses of up to 50 percent of the test pressure are permitted

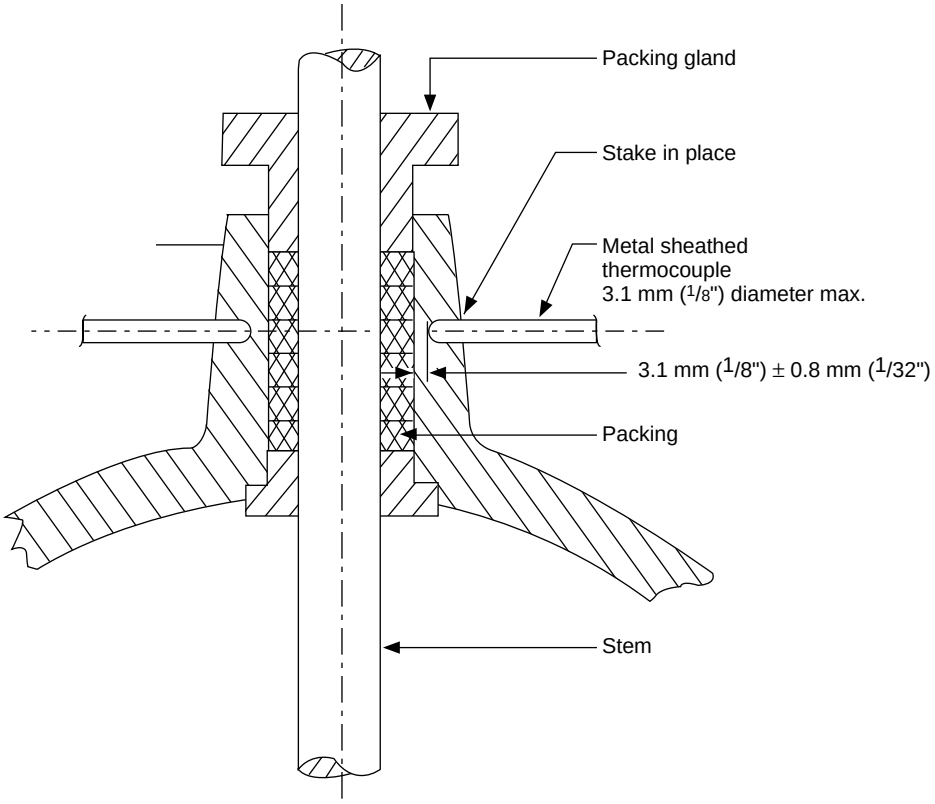


Figure 4—Location of Thermocouples in Stuffing Box Wall

during the fire test provided that the cumulative time for pressure recovery is less than 2 minutes.

6.2.6 Record instrument readings (Item 8 of Figures 1 and 2; and Items 14 and 15 of Figure 1) at least every 30 seconds for the duration of the test.

6.2.7 Close the fuel supply valve at the end of the test period.

6.2.8 Spray the test valve with water so that it rapidly cools to below 100°C (212°F) within 10 minutes.

CAUTION: For safety, no personnel should approach the valve until it has cooled to 100°C (212°F) or less.

6.2.9 Record the amount of water lost from the vessel (Item 4 of Figures 1 or 2). Use the volume of water lost divided by the elapsed time to compute the leak rate per NPS (ml/min/NPS) for the burning and cooling-down periods.

6.3 LOW-PRESSURE HYDROSTATIC TEST

Note: The tests in 6.3 and 6.4 are completely separate from the fire exposure tests in 6.2 in which data were recorded during the burning and cooling-down periods.

Lower the test pressure to 0.35 MPa (50 pounds per square inch gauge) ±10 percent. Allow the system to stabilize for 3 minutes; then measure and record the packing leakage over a period of at least 5 minutes and compute the packing leak rate per NPS (ml/min/NPS). No adjustments to the packing gland shall be made either before or during this test.

6.4 OPERATIONAL TEST

After completing the low-pressure hydrostatic test, raise the pressure to 3.72 MPa (540 pounds per square inch gauge) ±10 percent. Allow the system to stabilize for 3 minutes; then, with the full test pressure applied, move the stem to the fully closed position and then to the fully open position (see note below). If the stem has a backseat, move the stem the approximate equivalent of one hand-wheel turn back toward the closed position to unseat the backseat. Measure and record packing leakage for at least 5 minutes and compute the packing leak rate per NPS (ml/min/NPS). No adjustments to the packing gland shall be made either before or during this test.

Note: Protective shields must be in place when operating the valve or test fixture.

7 Performance Requirements

7.1 PACKING LEAKAGE

7.1.1 The maximum allowable packing leak rate for the total fire-test period, including the cooling-down period, shall be as listed in Table 1.

7.1.2 The maximum allowable packing leak rate for the low-pressure hydrostatic test shall be as listed in Table 1.

7.1.3 The maximum allowable packing leak rate for the operational test shall be as listed in Table 1.

7.2 PACKING QUALIFICATION

One fire test may be used to evaluate a specific packing configuration of either a uniform material and construction or a combination or an arrangement of more than one material and/or construction. Results of a tested packing configuration (see "packing configuration" in Appendix A) may not be assumed to be equivalent for variations of that packing configuration. Once a packing has been tested and qualified, any subsequent change in packing material or configuration requires full requalification.

7.3 CERTIFICATION AND WITNESSING OF TESTS

7.3.1 Requirements for certification and witnessing of tests shall be by agreement between the manufacturer and the purchaser.

7.3.2 Records of the tests upon which certification is based shall be available for the purchaser's review upon request.

Table 1—Maximum Allowable Packing Leak Rates

Test Period	Max. Allowable Leak Rate per NPS (ml/min/NPS)
Pretest hydrostatic	0
Fire-burn & cooling-down period	10
Low-pressure hydrostatic test after cooldown (5 minutes)	0.5
Operational test after cycling (5 minutes)	10

APPENDIX A—TEST RESULT SUMMARY
API STANDARD 589—SECOND EDITION

Test Number:	Test Date:
Packing material:	Style Number:
Packing manufacturer:	
Test Valve Size:	Actual Valve _____ or fixture_____
Packing Gland OD and ID (at the packing): OD= ID =	Packing gland bolt diameter =
Packing Configuration: Number of rings tested _____ Ring shape (square, circular, vee) _____ Solid or split _____ Circle the following: Braided Die formed Spool stock Wire or other reinforcement Corrosion inhibitor & type Other _____	Show sketch of packing installation—define each ring:

Packing compression % of free height =_____
Torque on gland nuts (each side) = _____/ _____ as installed
_____/ _____ after hydrotest
_____/ _____ after burn

Leakage Measurements:		Maximum Allowable Rate per NPS:
During two minute pretest hydrotest:	total (ml) = _____; rate (ml/min/NPS) =_____	0
During burn and cooldown:	total (ml) = _____; rate (ml/min/NPS) =_____	10
During 5 minutes following cooldown:	total (ml) = _____; rate (ml/min/NPS) =_____	0.5
After closing and opening (not back seated):	total (ml) = _____; rate (ml/min/NPS) =_____	10

Packing Qualification:

The packing tested complies with the performance requirments of this standard

The packing tested fails to comply with the requirements of this standard for the following reasons:

_____

Test conducted by:

_____ _____ _____
Name, title, company Signature Date

Witness:

_____ _____ _____
Name, title, company Signature Date

Additional copies available from API Publications and Distribution:
(202) 682-8375

Information about API Publications, Programs and Services is available on the World Wide Web at: http://www.api.org

American Petroleum Institute

1220 L Street, Northwest
Washington, D.C. 20005-4070
202-682-8000

Order No. C58902